APPENDIX O1

Design Decisions

I-405, SR520 to SR522 Stage 1
(Kirkland Stage 1)

Final Package Review – 15%

January 25, 2005

INTERSTATE 405 Project Team

Congestion Relief & Bus Rapid Transit Projects

January 25, 2005

Table of Contents
I-405, SR520 to SR522 Project Stage 1
Design Decision Reports

Executive Summary of Construction Staging Options

The following table highlights the key issues involved in determining a construction staging plan for Stage 1 of the Kirkland Nickel Project. Four different staging plans were studied from traffic, structures, design and staging perspectives. A build to the east option was rejected because of ROW, while building to the west would require widening the BNSF structure. The following two options are considered feasible, though not preferred, by all disciplines.

Issue	**Crossover**	**3 Stage**
Description	Cross SB traffic onto existing NB bridge to build entire SB bridge	Separate SB HOV and GP lanes to build SB bridge in 3 stages; ½ mile split length with max gap of 30′
Design Speed	50 mph minimum; higher design speeds may be possible	60 mph
Safety	Lower ML design speed; tight ramp merges	Limited area (30′) for construction of middle span between live traffic could increase danger to construction workers
Construction Cost	Reworking of items from the 128th Project (throwaway)	Additional $600K for SB Implementation Bridge beyond nickel limits (not throwaway)
Staging Cost	Coordination with 128th project could result in additional costs	Increased complexity of bridge construction
Duration	15 months total time for bridge construction – 4-5 months with crossover from August 2006 to January 2007	15 months time for bridge construction – 8-10 with split mainline traffic from August 2006 to August 2007
Coordination with 128th Project	Extensive coordination of traffic control signing and phasing, construction items (final wearing course, barrier placement and final striping)	Limited coordination of traffic control signing and final striping.
Forbes Creek	Simpler construction staging by keeping SB traffic on NB side until south of Forbes; Use a local crossover for NB traffic to build NB bridge	Local crossovers necessary for both NB and SB.
Public Perception	Reconstructing items built by 128th project	
Schedule	Cannot be constructed concurrent with ML 128th project; subject to complications if 128th keeps slipping	Minimal risk for delay from 128th project slipping
Other Risks	Change orders from DB or 128th project over coordination/schedule delays	

See the NE 116th St Staging Design Decision for a more complete description of the options and issues.

November 1, 2004

DESIGN DECISION

By Caroline Barnett, Jeremy Miles, Dustin Cooley

Subject Staging options for I-405, SR520 to SR522 Stage 1

Background

The Kirkland Nickel Project Stage 1 will replace the existing overstructures at NE 116th St. I-405 will be widened to 5 lanes in each direction, 1 HOV lane and 4 GP lanes, from the existing 4 lanes. The profile of I-405 will be raised to provide adequate vertical clearance over NE 116th St. when the bridges are widened to their ultimate widths in the Implementation Plan. The twin bridges will be steel girders, with a 150' span length and a 6' structure depth. The NB 405 bridge will be raised approximately 6' and the SB 405 bridge will be raised approximately 4' over the existing bridge elevations.

Construction staging requirements are that 4 lanes of traffic be maintained at all times in both directions of 405 except for temporary nighttime closures. The minimum desirable speed limit during construction is 60 mph, except when there is a major traffic movement, i.e. a crossover, where the speed limit may be reduced to 50 mph. 11' lane widths and 2' shoulders are the minimum section permitted, except across a structure when a 1' shoulder is acceptable. All other design parameters must be met. Ramp design speeds may be 10 mph lower than the mainline design speed in the area.

An additional consideration is the proposed structure to be built at Forbes Creek. This structure will be a new, 30' span, concrete bridge built to provide fish passage under I-405. The construction staging of this bridge will need to work with the staging at NE 116th St. structures. Construction schedules and phasing must be coordinated with the NE 128th St. HOV project which is expected to be under construction at the same time. The NE 128th project will widen I-405 between NE 124th and NE 132nd Sts to build an HOV direct access connection at NE 128th St.

Study

In studying construction phasing options, we looked at one crossover option and three non-crossover options. The criteria considered are the resulting permanent alignments, compatibility with the proposed Implementation Plan, compatibility with Forbes Creek construction staging and construction cost and duration.

Option 1 - Crossover

Description

Phase 1 would restrict lane and shoulder widths on the existing NB 405 bridge to shift traffic to the west, demolish the eastern portion of the existing bridge and build the portion of the new NB bridge to the east. Phase 2 would put NB traffic on the new NB structure, cross SB traffic over to the existing NB structure and demolish and rebuild the entire SB 405 structure. Finally, SB traffic would be routed onto the new SB structure while the existing NB structure is demolished and the new structure completed. Exhibit 1 shows a schematic diagram of the proposed bridge construction phasing.

Discussion

The crossover to the north of NE 116th St will require coordination with the 128th project. Based on current schedules, the crossover will be constructed after the proposed mainline widening by the 128th project, which will lower the profile of NB 405, relocate the SB on ramps from NE 124th St and repave the entire surface of I-405. Based on the current schedules, the 128th Direct Access ramps would be open for traffic, while construction on the surrounding arterial streets is being completed.

In this area, both NB and SB 405 are transitioning from a 5% superelevated section over the BNSF structures to normal crown under the NE 124th St undercrossing structures. In addition, existing SB 405 is approximately 3-4 feet higher than existing NB. Exhibit 1 assumes that temporary pavement will be added to NB 405 without removing pavement from SB 405, resulting in SB traffic being completely clear of the existing SB pavement before any changes in the profile are made. Pavement cannot be added or removed from the BNSF structure; therefore SB 405 must match the existing profile and superelevation rate across this structure.

The SB on ramp from NE 124th St would be routed to merge into the SB lanes during the horizontal transition onto the NB lanes using a parallel on connection. The full 300 feet parallel lane could be provided for merging, but the taper length would need to be shortened from the standard 300 feet to approximately 225 feet, a 20:1 rate. This would require removing the single slope barrier between the ramps and mainline. An additional option for this ramp would be to route it across the SB BNSF structure and then merge it into the SB mainline traffic. This could be continued during bridge construction, but would not be an option while the profile of SB 405 is raised between the BNSF structure and NE 116th St.

The 128th Direct Access ramp connects on the inside of SB 405 before the crossover. This ramp will be open to traffic during the operations of the crossover. The gap acceptance length of the parallel on connection would be shortened by the crossover option to a length meeting a design speed of 49 mph. The taper length at the end of the ramp would be shorted as well to 270 feet from the desired 300 feet. The represents a taper rate of 25:1.

South of NE 116th St, SB traffic could be crossed back onto the SB mainline without any complications. All elements of the crossover could be constructed to meet the proposed design speeds, with 50 mph necessary at the north end but 60 mph attainable at the south end. The Implementation Plan would widen both structures at NE 116th St to the west.

Using a crossover to construct the structures over NE 116th St. allows simpler construction staging for the Forbes Creek structures. The crossover back to SB would be pushed south of Forbes Creek; construction of the SB structures at NE 116th St. and Forbes Creek would be concurrent. A local crossover would be necessary for construction of the NB structure at Forbes Creek. This local crossover could be designed at 60 mph.

Cost and Duration

The majority of the costs associated with the crossover option will be temporary and will not require expansion of the scope of the Kirkland Nickel Project. The challenge of the crossover north of NE 116th St is the removal and replacement of items recently constructed by the 128th project. The construction cost of the items is less important than the political cost of reconstructing items that were just built. The following aspects of the 128th project would be redone by the Nickel crossover:

- 820 feet of new striping on SB 405
- 1,100 feet of new pavement and striping on NB 405
- 550 feet of new striping on the SB On ramps from NE 124th St
- 200 feet of single slope barrier between the 124th SB On Ramps and SB 405
- 550 feet of new median barrier between NB and SB 405

Additionally, this staging plan will use existing inside shoulders as travel lanes. Approximately 2,300 feet of the existing inside shoulders may need to be upgraded to a temporary pavement section capable of supporting traffic for the duration of construction staging. Shoulders that will eventually be used as travel lanes, even in the Implementation Plan, must be upgraded to full depth pavement. The total estimated cost of the shoulder upgrades is $89,000, including soft costs, inflation and a 5%

contingency. The majority of this pavement will be in areas that will be reconstructed as part of raising the mainline profile, so will only need to be temporary pavement.

Total construction time for the bridges would be 18 months. The crossover would be the second stage of bridge construction and would last approximately 6 months from August 2006 to January 2007.

Option 2 - Build SB East of Existing Location

Description

Phase 1 would restrict lane and shoulder widths on the existing NB bridge to shift the traffic to the west, demolish the eastern portion of the existing bridge and build the portion of the new NB bridge to the east. Phase 2 would shift NB traffic onto the new NB bridge and restrict lane and shoulder widths on the SB bridge to shift traffic to the west. The eastern portion of the existing SB bridge and the remainder of the existing NB would be demolished and the new SB structure would be built between the existing SB structure and the proposed NB structure. Phase 3 would put SB traffic onto the new SB structure, demolish the existing SB structure and complete the construction of both bridges. Exhibit 2 shows a schematic diagram of the proposed bridge construction phasing.

Discussion

SB 405 mainline would be shifted approximately 25 to 30 feet east of the existing location under this plan. The mainline shift would reduce the inside shoulder width across the BNSF structure to 4 feet and would require a taper rate of 45:1 on SB 405. Both of these deviations would be permanent; the Implementation Plan widening of the BNSF structures would not eliminate or alleviate them. The Implementation Plan would widen the NE 116th St and the BNSF overcrossing structures to the west for SB and the NB structures to the east.

This proposed alignment would shift NB 405 approximately 50 feet east of its current location. This shift would also push the NB off ramp further east of its current location and prohibit possible alignments that kept the limited access reference point more than 300 feet from the gas station driveway. The result of this configuration would be a limited access acquisition of one gas station driveway, which could result in condemnation of that business. Additional limited access control measures may also be necessary at some of the other driveways in this area, though these are not likely to result in condemnation. Closing driveways and restricting access is a not considered a desirable outcome by the City of Kirkland.

Building the structures at Forbes Creek would be done with local crossovers independent of construction of the NE 116th St. overcrossing structures.

Cost and Duration

The major cost of this option is the ROW acquisition. The cost of acquiring the Conoco Phillips 76 gas station through condemnation has been estimated at $3 Million. While this cost would be incurred in Stage 2, it would still be necessary with this proposed alignment when the half-SPUI is completed. Additional access control measures could also be imposed in addition to this cost.

Total construction time for the structures at NE 116th St would be 18 months

Option 3 - Build SB West of Existing Location

Description

Phase 1 would restrict lane and shoulder widths on the existing NB and SB bridges to shift traffic to the inside (east on the SB bridge, west on the NB bridge). The outside portions (east for NB, west for SB) of the existing bridges would be demolished and portions of the new structures built. Phase 2 would shift traffic onto the new structures, demolish the existing structures and complete construction of the new structures. Exhibit 3 shows a schematic diagram of the proposed bridge construction phasing.

Discussion

This option features a two stage construction schedule, that could be used to shorten construction duration and cost. By shifting both NB and SB alignments approximately 30 feet wider than the existing locations, it would be possible to build both new bridges while running traffic on the existing structures. The constraint of the BNSF structure, in terms of horizontal, vertical and cross slope controls, does not allow a SB alignment to work without widening the BNSF structure. Two different alternative alignments were developed in an attempt to minimize the impacts to the BNSF structure.

Alternative 1 would have a single curve beginning just north of the BNSF structure and continuing across NE 116th St. The radius of a curve necessary to match the existing cross slope on the BSNF structure forces the alignment to swing out to the west. It is not possible to match the cross slope on the BNSF and not need to widen the bridge to accommodate the 30 foot shift at 550 feet south at NE 116th St. The total widening necessary on the BNSF structure would be 16′ at the SW corner, tapering to 6′ at the NW corner.

Alternative 2 would have two small curves separated by a short (365 feet) tangent section beginning south of NE 116th and the tangent section just north of the BNSF structure. These radii allow the design to match the cross slope over the BNSF structure and still swing wide enough to allow two stage construction of the new NE 116th structure. This design impacts the BNSF structure by requiring an 8′ widening to the SW corner of the structure tapering to the existing EOP at the NW corner of the structure. However, this design introduces a "broken back" curve to the alignment and could result in a superelevation deviation. The tangent is not long enough to transition to normal crown between the two curves, though a transition to an adverse crown would be possible. This option would require transitioning superelevation across the new NE 116th St structure.

Building the structures at Forbes Creek would be done with local crossovers independent of construction of the NE 116th St. overcrossing structures.

<u>Cost and Duration</u>

The Implementation Plan is to widen the SB BNSF structure by 19 feet. If it is necessary to widen this structure for construction of the Nickel Project, it would be desirable to construct the ultimate widened width. The cost of the widening this structure is estimated to be $150 / SF. The full (Implementation) widening of the bridge is 5,000 SF, for a total estimated cost of $1.24 Million, including soft costs, inflation and a 5% contingency. A tapered widening of the BNSF structure is possible, but not desirable from a structural standpoint. For Alternative 1, a 16′ desired widening would result in building the full planned 19 foot widening, due to the impracticality of widening by 3 feet, or accepting deviations to lane or shoulder widths in the future. For Alternative 2, an eight foot widening of the entire structure would be recommended, which means 2,120 SF of structure for a total estimated cost of $530,000. The NB BNSF structure would not need to be widened as part of the Nickel project.

Total construction time for the structures would be 12 months. This assumed concurrent construction of the new SB structure and the widening of the BNSF in Phase 1.

<u>Option 4 - Construct SB Bridge in 3 Stages</u>

<u>Description</u>

For this option the NB bridge would be constructed in the same manner as for the Crossover Option. The following description focuses on the SB bridge only.

Phase 1 would restrict lane and shoulder widths on the existing SB bridge to shift the traffic to the east. The western portion of the existing bridge, approximately 16′ of structure width, would be demolished and a portion of the new SB bridge to the west, approximately 43′ of structure width, would be built. Phase 2 would split mainline traffic, with the three GP lanes on the new structure while the HOV lane would be shifted to the west on the existing bridge. The eastern portion of the existing bridge, approximately 28′ of structure width, would be demolished and another portion of the new SB bridge, approximately 25′ of structure width, would be built in its place. Phase 3 would shift the HOV lane from the existing SB bridge onto the new 25′ bridge structure. The center section of the existing SB bridge would be demolished and the remaining section of new bridge would be constructed.

Exhibit 4 shows a schematic diagram of the proposed bridge construction phasing.

Discussion

Both the geometric and structural components of this option are not desirable, though are definitely possible. Splitting mainline traffic in a construction zone and building a bridge with two closure pours would both be departures from standard construction practice. The complexity of construction staging for this option would be much higher than for the other options, especially with the final stage of bridge construction occurring between travel lanes with live traffic. Additional traffic control, temporary bridge shoring and temporary barriers along travel lanes will be required.

The safety of the construction workers would be less with this option. Construction would be necessary between two lanes of live traffic. There would be a minimal amount of room for construction equipment and workers north of NE 116th St. Most of the construction equipment would need to be located to the south. The split in mainline traffic does not conform to driver expectations and could result in unsafe driving conditions as drivers adjust to the traffic control plan.

This option would also require building the full implementation width to accommodate the proposed traffic configurations during construction. The actual horizontal alignment of the bridge is very similar to the alignment proposed in the crossover option. During construction, 11 foot lanes and a 1 foot shoulder would be used for the three traffic lanes across the structure. The single lane would have only 16' of total roadway width, a 12 foot lane and 2 foot shoulders. These widths are based on structural preferences that live traffic not run on a cantilevered portion of the bridge. Outside of the bridge construction zone, roadway section widths would be widened to the construction zone minimums stated above.

The crossbeams and columns on the interior piers of the existing structure would need to remain in place until the final section of the existing bridge is demolished in Phase 3. Because the final existing bridge section is straddling the interior column, the adjacent columns and crossbeams would be necessary to support the superstructure. This would not interfere with the construction of the new structure, which is at least three feet higher than the existing mainline. There would be a two foot vertical gap between the existing top of crossbeam and the bottom of new superstructure.

Building the structures at Forbes Creek would be done with local crossovers independent of construction of the NE 116th St. overcrossing structures.

Cost and Duration

The cost of constructing and demolishing a bridge in 3 stages would be considerably higher than the two stage options. The additional traffic control necessary to split mainline traffic would also be higher in this option than in the other staging options. An estimate of the additional construction costs associated with the temporary shoring and other staging items is not feasible given the current level of design. The Implementation Plan is to widen the NE 116th St overcrossing structures by 16 feet. The construction cost of the additional SB bridge width is estimated at approximately $600,000 including soft costs, inflation and a 5% contingency. The NB bridge would be built to Nickel dimensions only.

This option would require 18 months for bridge construction. Phases 2 and 3 would both require splits in mainline traffic. Total duration of the split mainline traffic would be 12 months, estimated to be from August 2006 to August 2007.

Conclusion

Due to the differing bridge locations between all options, a preferred option must be selected to be shown on the RFP plans. It is recognized that the design-builder can and will choose to construct the project in a potentially different manner from any of the options considered here.

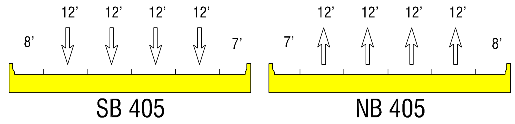
Option 2, building to the east, is not a preferred option due to the necessity of a future ROW take when Stage 2 is built.

Option 3, building to the west, is not a preferred option due to the necessity of widening the SB BNSF structure. While this bridge will be widened in the Implementation Plan, it is not desirable to build this additional width today.

Option 1, the crossover, is a feasible staging plan. The benefits of the crossover are a shorter disruption to traffic, easy construction of a potential structure at Forbes Creek, and a safer construction zone for workers. Another benefit is the simplicity of constructing the SB 116th structure in one stage. The downsides of this option are the lower design speed, the reconstruction of elements of the 128th project and the dependence of this option on work being completed by the 128th project.

Option 4, the 3-stage bridge construction, is also a feasible plan. This option has several downsides, including increased difficulty of construction, increased cost, and splitting the HOV lane from GP traffic. The benefits of this option are the greater design speed, no overlap with the 128th project and the independence of construction schedules from the 128th project.

At this point, it is unclear when the 128th project will be constructed. Because of its relative independence from the 128th project, Option 4 is preferred at this time. Coordination between the two projects will still be necessary for traffic control and work zone signing.



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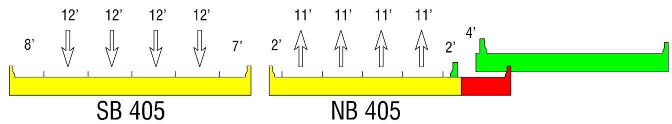

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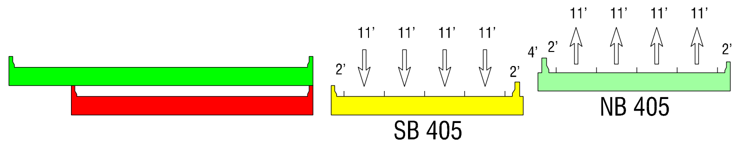

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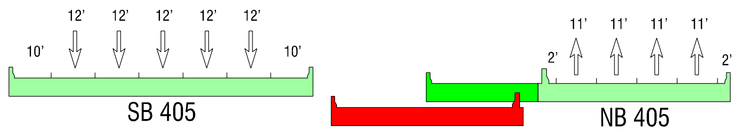

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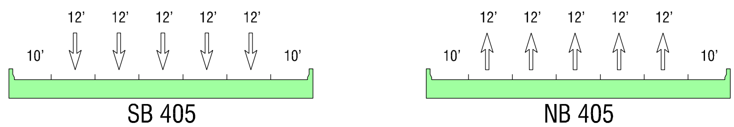

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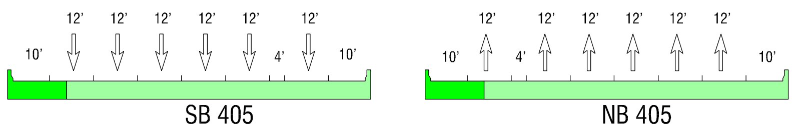

IMPLEMENTATION

WIDEN NICKEL BRIDGES 16'

EXISTING
BUILT IN CURRENT STAGE
BUILT IN PREVIOUS STAGE
EXISTING TO BE DEMOLISHED

INTERSTATE 405 Project Team

Washington State Department of Transportation

I–405 CONGESTION RELIEF & BUS RAPID TRANSIT PROJECTS

I-405 MAINLINE MAINTENANCE OF TRAFFIC
OPTION 1 - CROSSOVER

DATE
11/02/04

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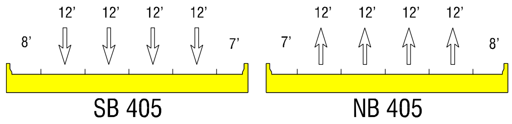

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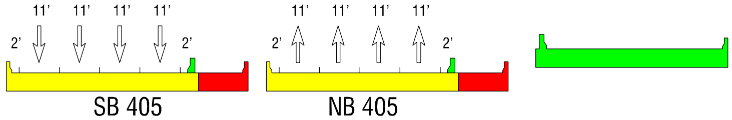

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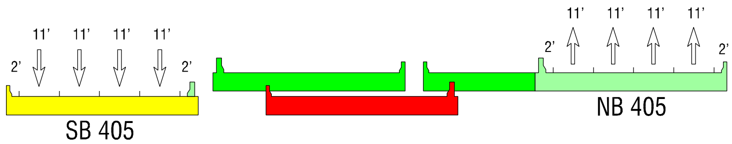

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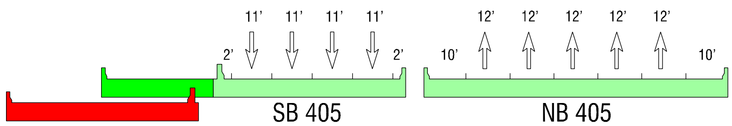

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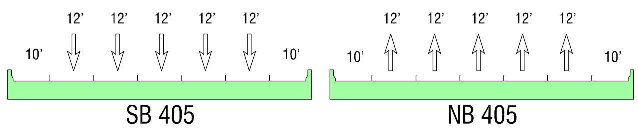

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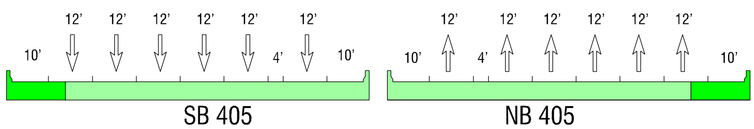

IMPLEMENTATION

WIDEN NICKEL BRIDGES 16'

- EXISTING
- BUILT IN CURRENT STAGE
- BUILT IN PREVIOUS STAGE
- EXISTING TO BE DEMOLISHED

INTERSTATE 405 Project Team

Washington State Department of Transportation

I–405 CONGESTION RELIEF & BUS RAPID TRANSIT PROJECTS

I-405 MAINLINE MAINTENANCE OF TRAFFIC
OPTION 2 - BUILD SB EAST

DATE 11/02/04

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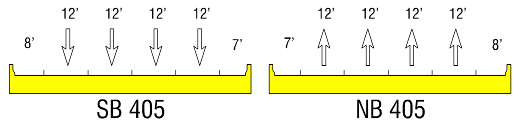

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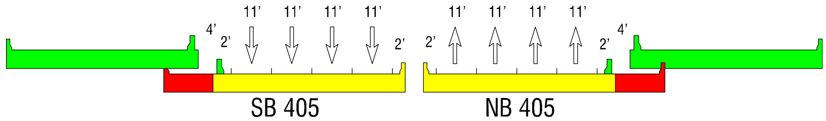

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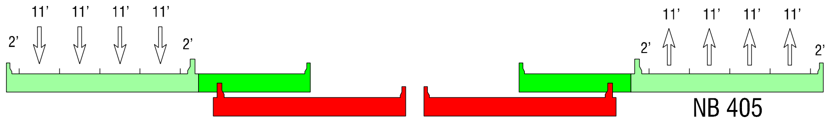

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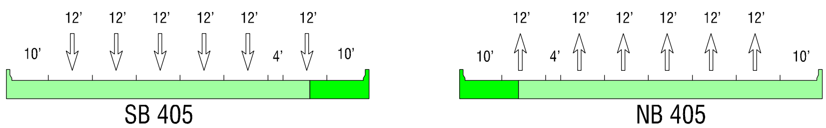

IMPLEMENTATION

WIDEN NICKEL BRIDGES 16'

EXISTING

BUILT IN CURRENT STAGE

BUILT IN PREVIOUS STAGE

EXISTING TO BE DEMOLISHED

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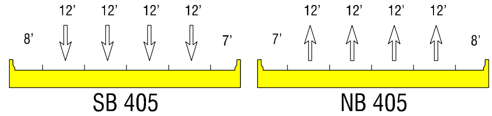
INTERSTATE 405 Project Team

Washington State Department of Transportation

I-405 CONGESTION RELIEF & BUS RAPID TRANSIT PROJECTS

DATE 11/02/04

I-405 MAINLINE MAINTENANCE OF TRAFFIC
OPTION 3 - BUILD SB WEST



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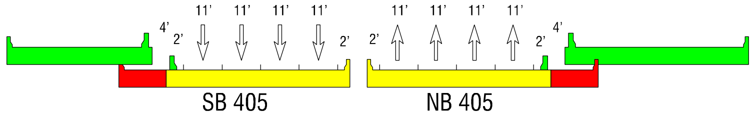

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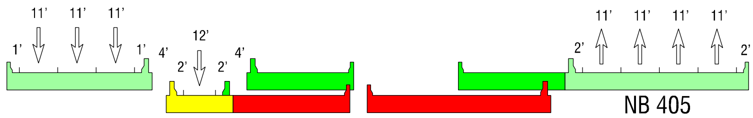

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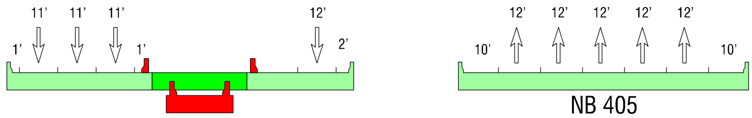

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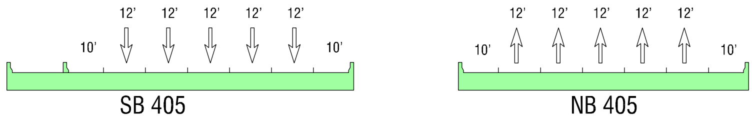

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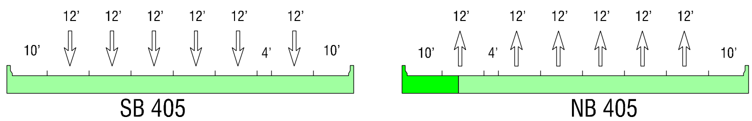


IMPLEMENTATION

WIDEN NICKEL NB BRIDGE 16'

- EXISTING
- BUILT IN CURRENT STAGE
- BUILT IN PREVIOUS STAGE
- EXISTING TO BE DEMOLISHED

INTERSTATE 405 Project Team

Washington State Department of Transportation

I-405 CONGESTION RELIEF & BUS RAPID TRANSIT PROJECTS

I-405 MAINLINE MAINTENANCE OF TRAFFIC
OPTION 4 - 3 STAGE

DATE
11/02/04

Interoffice Correspondence

November 1, 2004

DESIGN DECISION

By Caroline Barnett, Dustin Cooley

Subject SB405 Compound Horizontal Curves

Background

Initially, the SB405 alignment proposed across the BNSF and NE 116th St. consisted of a long, simple curve. The radius was high enough to meet the super requirements of the existing BNSF structure. The constructibility review conducted on September 14, 2004, revealed that the alignment shown was not constructible. Further investigation revealed that no simple curve could be fit across both the BNSF and new 116th structure to meet all design and constructibility requirements.

The Kirkland Nickel project will not impact the BNSF structures; the horizontal and vertical alignments and superelevation across the structure cannot be altered. The existing rate of superelevation across the BNSF structure is 5%. Based on a crossover staging option, the new SB bridge must be located at least 4′ horizontally from the edge of the existing NB overcrossing structure at NE 116th St.

Study

Two different alignment options were considered – compound horizontal curves and a broken back curve.

The design requirement for compound curves in the Design Manual (page 620-2) is that the smaller radius must be at least two-thirds of the larger radius. The proposed alignment is a 4450′ radius compounded with a 3900′ radius across the BNSF structure. A 5% superelevation rate would be carried through both curves.

The "broken back" alignment option would have two 3500′ radii curves separated by a 305′ tangent. Both curves would have a 5% super rate. The tangent length is sufficient to transition from 5% to a 2% reverse crown to a 5% super rate for the second curve.

Conclusion

Based on a 65 mph design speed, the tangent between the broken back curves would be covered in approximately 3 seconds. A driver would not have enough time to recognize that one curve has ended, correct the steering for a tangent, and begin to steer into the next curve. Likely, a driver will not notice the end of one curve and the beginning of the next.

Compound curves are preferred by the WSDOT Design Manual and will be used for the SB alginment.

October 18, 2004

DESIGN DOCUMENTATION

By Gene Niemasz

Subject Wetland Impact Avoidance and Minimization

Introduction

As design development and permit coordination activities proceed for the I-405, SR520 to SR522 (also referred to as the Nickel Project), project several classified wetlands have been encountered along the freeway corridor. Roadway and storm drainage improvements may create impacts to these sensitive areas where features come into contact. The purpose of this document is to identify which measures have been developed to avoid or minimize impacts to wetlands and associated buffer areas.

Background

Stream courses, wetlands, jurisdictional ditches and other sensitive areas have been identified and delineated for the Nickel Project. When compared with proposed roadway and storm drainage improvements, avoidance and minimization activities became necessary in certain locations to reduce impacts on sensitive areas and to facilitate permit coordination.

King County's GIS wetlands data was used as the initial guideline for identification and designation of wetlands along the corridor. As the design evolved, wetlands areas were field delineated by qualified wetland biologists, and surveyed. The field delineation resulted in 39 additional wetlands areas that were not part of the King County GIS data. Most of these new wetland areas are the result of natural establishment within roadside ditches. This new wetland information was imported into the design CAD drawings, and the design was refined, where possible, to avoid wetland and buffer impacts.

Summary

For a complete listing of all wetlands within the project limits and accounting of wetlands impacts, refer to the Wetlands Discipline Report, Table 2.

The design was refined in the following areas to minimize wetlands impacts:

Wetland 18.96R – design refinements resulting in complete wetlands avoidance include; addition of a headwall at end of a culvert, and revised grading to reduce footprint area.

Wetland 19.07R – design refinements resulting in complete wetlands avoidance include; addition of a headwall at end of a culvert, and revised grading to reduce footprint area.

Wetland 19.5L – design refinements resulting in minimized impacts include; extended retaining wall limits, revised grading and revised drainage vault location.

Wetland 19.7R – design refinements resulting in minimized impacts include; construction of a retaining wall to reduce footprint area.

Wetland 19.8L – design refinements resulting in minimized impacts include; revised grading to reduce footprint area.

Wetland 21.6L – design refinements resulting in minimized impacts include; revised grading to reduce footprint area.

Wetland 21.7L – design refinements resulting in minimized impacts include; revised grading to reduce footprint area.

Wetland 22.5L – design refinements resulting in minimized impacts include; revised grading to reduce footprint area.

Wetland 23.2L – design refinements resulting in minimized impacts include; lengthened retaining wall and revised grading to reduce footprint area.

Interstate 405 Project Team
Congestion Relief & Bus Rapid Transit Projects

Interoffice Correspondence

October 18, 2004

DESIGN DECISION

By Dustin Cooley/Matthew Klontz

Subject Modified Grading – I-405, SR 520 to SR 522

Background

The purpose of this memorandum is to document the current design decision to modify the inside and outside grading throughout the I-405, SR520 to SR 522 project. Adjusting these slopes minimized the impacts to wetlands, trees, existing sound walls/berms, and overall footprint.

Discussion

Modified cut ditch section was comprised of a 4'-10:1 slope from the EOP (guardrail), 8'- 4:1 ditch fore slope, 2' flat ditch bottom, & 2:1 slope up to match existing ground or if needed a wall offset from obstruction/ROW. Also a modified fill section was used in some areas and was comprised of a 4'-10:1 slope from the EOP (guardrail), & a 2:1 slope down to existing ground or if needed a wall offset from obstruction/ROW. Due to the steepened slopes in these modified sections guardrail will be required. A 4' area has been provided off the EOP to accommodate the needed guardrail.

Description	SB Station Range	Adjustments
Bridal trails tree impacts.	4031+50 to 4036+75	Due to limited room between Nickel/Imp. to the ROW & exist./prop. Walls we will not be able to reduce impacts to the trees.
Bridal trails wall impacts.	4031+50 to 4036+75	Used modified ditch section along w/ guardrail to reduce the mainline cut slope. This allowed for the room needed to place a drilled shaft wall inside the existing ROW w/o impacting the existing sound wall.
116th slope modification.	4261+75 to 4271+75	Used modified ditch section along w/ guardrail to reduce the mainline cut slope and remove the impacts to existing 116th street.
Spinney Homestead berm impacts.	4166+75 to 4172+00	Used modified ditch section along berm area to minimize impacts to the existing noise berm.
Spinney Homestead SB tree impacts.	4166+75 to 4172+00	Used modified ditch section along this area to minimize impacts to existing trees.
Spinney Homestead NB tree impacts.	4175+50 to 4200+00	Unable to modify side slope treatment to minimize tree impacts in this area. The slopes were already minimized and EOP was close to the ROW through out this area.

Widen west design impacts. Cont.	4290+00 to 4325+70 Cont.	For this design alternative a modified ditch section was used along the west side of SB405 to minimize impact to an existing noise berm. A 2:1 slope was also used at a 2' offset from the existing ROW and projected to intersect the mainline modified ditch section. These intersecting 2:1 slopes created a new noise berm but required a modification of the existing drainage at the toe of the existing noise berm and a possible addition of a sound wall off the top of the new proposed noise berm.
Widen east design impacts.	4277+80 to 4325+70	For this design alternative a modified ditch section was used on both sides of SB405. To minimize impacts to existing noise berm to the west and help keep implementation impacts to a minimum this design alternative was sifted to the east. The modified slopes helped to minimize the impacts the wetlands located in the median.
Culvert 32 grading.	4328+16	There were no impacts related to culvert 32 due to proposed grading. Proposed grading contained a wall that stopped short of the pipe outlet.
Culvert 31, 30, & 29 grading.	4315+79, 4308+60, 4301+35	If widen east design alternative is used through this area there will be no impact these existing culverts. I the widen west design alternative is used the culverts will need to be modified due to the noise berm fill overtaking the ends of the culverts.
Culvert 28 grading.	4294+00	The grading in this area has been modified to use a barrier and 2:1 fill slope so that the proposed design will not impact this culvert. The 2:1 slope intersects the existing ground before impacting the culvert.
Culvert 27 grading	4291+62	The grading in this area has been modified to use a barrier and 2:1 fill slope so that the proposed design will not impact the culvert or the detention facility (Nickel). The 2:1 slope intersects the existing ground before impacting the culvert or detention facility.
Forbes culvert (Culvert 20)	4176+90 to 4182+55	The grading in this area has been modified to use a barrier and 2:1 fill slope so that the proposed design will not impact the existing culvert.
Culvert 18 grading	4171+65 to 4172+45	Placed headwall at culvert outlet.
Pond C1.1	4172+50 to 4176+90	Relocated drainage pond to the south outside of 75' stream riparian zone. Used a 7' shoulder buffer (4' guardrail + 3' ecology ditch) and 2:1 side slopes to reduce impact. Pond location accommodates implementation channelization.
Pond E2	4362+00 to 4364+50	Relocated drainage pond north outside of wetland. Located headwall to limit shoulder

		grading in wetland buffer.
Pond F1	4358+75 to 4364+50	Relocated drainage pond to the east to accommodate implementation channelization.
Pond F2	4398+80 to 4400+15	Relocated offsite pond outside of wetland.
Vault C1.2	4191+80 to 4199+80	Verified vault can be located with increasing project footprint. Detailed vault grading not incorporated into DTM.
Vault A2	4051+75 to 4053+80	Verified vault can be located with increasing project footprint. Vault grading incorporated into DTM.
SBI405 to NE160 Off-Ramp	4363+95 to 4372+15	Ramp Grading
Wall Relocation	4372+15 to 4389+70	Set walls to minimize grading impacts to the west.

Conclusion

These modified sections have been added to the proposed DTM and can be seen in proposed contours and cross sections. Any change to geometry in these areas will require re-evaluation of the side slope treatment and its relation to the ROW or obstructions. At the time that guardrail is designed, guardrail lengths should be evaluated separately from the DTM and the DTM should be modified to reflect the length of need calculations.

Interoffice Correspondence

September 24, 2004

DESIGN DECISION

By Gene Niemasz

Subject Environmental Impact Areas

Background

For the purposes of defining permit requirements in a design-build style project, further definition of potential, actual and temporary environmental impacts was necessary.

Study

Design-Bid-Build

For a design-bid-build project, permits are obtained based on final design plans, with impacts defined by the cut/fill line. Impacted areas outside of the cut/fill line are considered temporary, and are either restored to pre-project conditions, or as directed by the general or special provisions to the contract.

Design-Build

For a design-build project, permits are obtained at the 15% design level, and the contract is written to promote design innovation, which may lead alterations in the cut/fill line, and thus the impacted areas. The concept of additional "impact" lines has been introduced to ensure that adequate mitigation is undertaken for identified resources, and to allow the design-builder the flexibility to adjust the cut/fill limits within a specified range without having to obtain new permits.

Conclusion

The following definitions have been developed to clarify impact areas:

Design Footprint (Cut/Fill Line)

The Design Footprint is simply the design cut/fill line established by the proposed roadway prism and drainage features (ponds, vaults, etc). The Design Footprint will be shown on the conceptual plans.

Impact Area

The Impact Area Line is generally a parallel offset to the smoothed cut/fill line. In the case of the Kirkland Nickel project, a 10 foot offset was used. This was intended as "wiggle room" for design refinements for the design-builder. This line is depicted on the conceptual plans, and is the boundary to which environmental mitigation will be determined. The design-builder may adjust the cut/fill line outward to Impact Area line, to construct within this area, and be covered under our permits.

Temporary Impact Area

The Temporary Impact line is a 10' parallel offset to the Impact Area, which will exist only along the environmentally sensitive areas as defined on the conceptual plans. The area between the Impact Area line and the Temporary Impact line is considered a temporary impact area. The contractor may work in this area (moving equipment, etc.), but must restore the area to pre-project conditions. No permanent grading will be allowed within the temporary impact area.

Right-of-Way

The Right of Way lines are the existing or proposed WSDOT property limits. Environmentally, resources are being assessed and analyzed between the right of way limits, e.g., wetlands will be mapped and surveyed. No archaeological resources were identified in the right of way between SR 520 and SR 522, so avoidance is not an issue. The contractor may use the full right of way for work zones and staging areas for materials and equipment, except as restricted by environmentally sensitive areas. Disturbed areas that are not within an Impact Area will be treated as described in the RFP under Roadside Restoration.

Environmental Analysis & Permits

Resource (wetlands, etc.) impacts should be defined within the Impact Area Line, separate from the temporary impact area. Permit applications should be written to allow full use of the right-of-way, as specified in the above line and area definitions, unless there will be resource impacts.

Work Zone Clarification

Impact Area

The Impact Area is the area between the existing roadway and the Impact Area line, or an area enclosed by and Impact Area line. The design-builder is free to adjust the cut/fill line out to the impact area line without consequence, unless restricted specifically in the RFP or conceptual plans.

Temporary Impact Area

The Temporary Impact Area is the area between the Impact Area line and the Temporary Impact Area Line. This area may be cleared, and used for construction, but must be restored to pre-project conditions, or as defined in specific permit conditions.

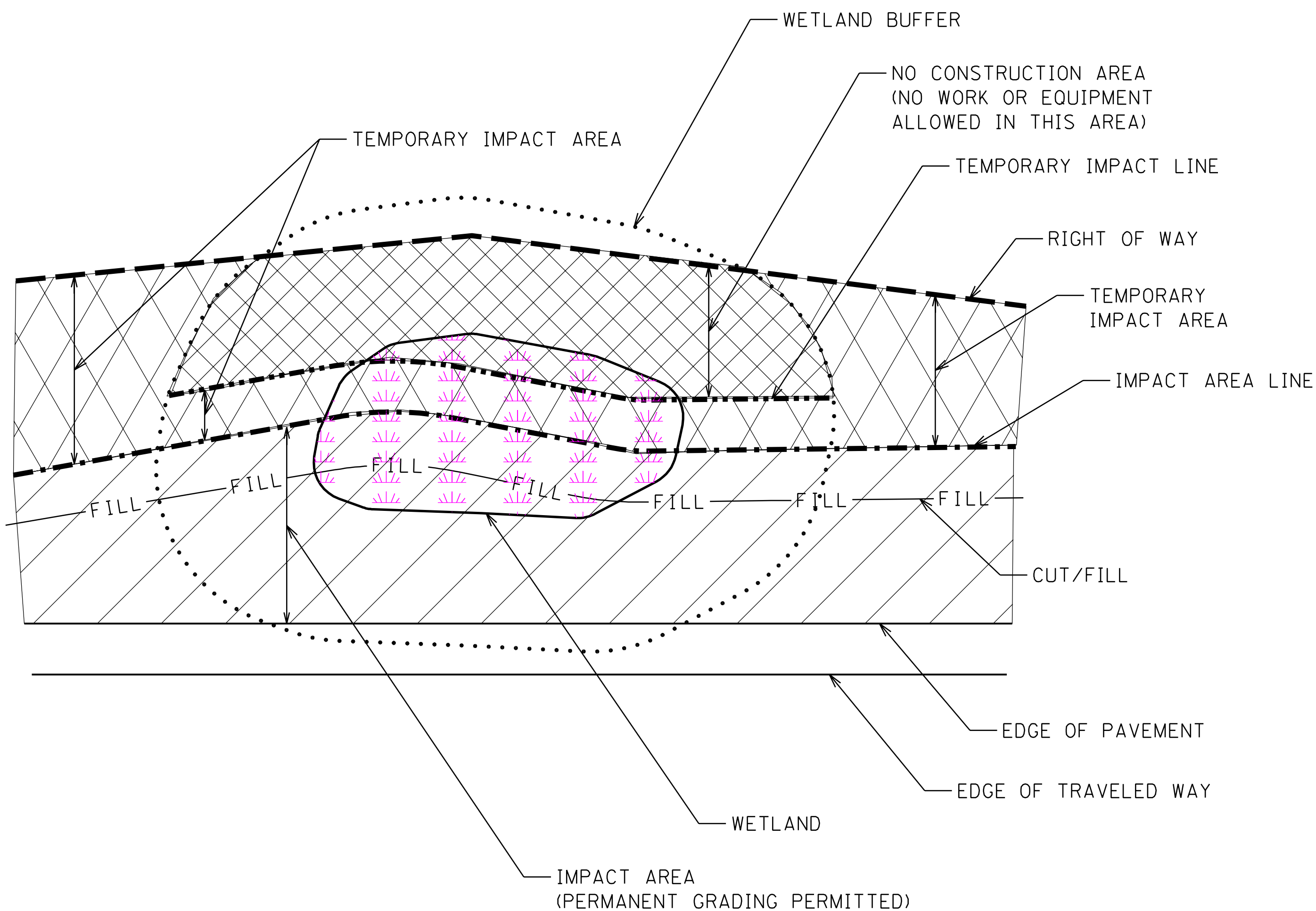
No Construction Area

No Construction Areas must be fenced with high visibility construction fencing. These are areas outside the temporary impact area where construction will be prohibited (along a defined resource). No work is permitted in this area.

Conceptual Plans, Permits, Final Plans & Construction

The cut/fill, Impact Area Line, Temporary Impact Area Line and Right of Way Lines are shown on the conceptual plans, permit exhibits and final construction drawings. The no construction areas will also be shown on the permit exhibits. The CAD drawing files depicting all of the impact lines and resource boundaries will be provided to the design-builder for their use in design and construction. The RFP and permit conditions will require high visibility construction fencing around wetlands and delineated buffers that are outside the temporary impact area.

ENVIRONMENTAL IMPACT AREAS AND TERMINOLOGY



Interoffice Correspondence

September 13, 2004

DESIGN DECISION

By Matthew Gray

Subject Forbes Creek Fish Passage Culvert – I-405, SR520 to SR522 Project

Background

The purpose of this memorandum is to document the current design options being considered to provide fish passage on Forbes Creek under I-405 near milepost 19.1. Washington Department of Fish and Wildlife (WDFW) have determined that the existing culvert is a fish barrier to native cutthroat trout and salmonid populations. Representatives of WDFW have stated that Washington State Department of Transportation (WSDOT) is legally obligated to remove the barriers and provide fish passage at this location.

The following alternatives are based on the assumption that trenchless construction methods will be used. The culvert alternatives are based on WDFW allowing WSDOT to provide fish passage using design options other than stream simulation. It is anticipated that a stream simulation culvert would be approximately 18 to 20 feet wide. The WDFW allowance is based upon the understanding that providing a stream simulation designed culvert using tunneling construction practices would be enormous. If the tunneling construction practice changed to an open trench approach, WDFW would insist on providing a fish passable culvert meeting the Stream Simulation Design Option.

Alternatives

Design concepts for the fish passage culvert have progressed to a point where two alternatives have emerged. The first alternative consists of jacking a new 78-inch diameter concrete culvert along the south side of the existing 42-inch diameter corrugated metal pipe (CMP) culvert at a nearly flat slope. A concrete fishway would be located at the downstream end of the proposed culvert to pass flows up to the maximum fish passage flow of 18 cfs. High flows would bypass the fishway. The fishway consists of two rows of approximately six pools per row. Each pool measures approximately 8 ft wide by 8 ft long by 4.5 ft deep. The fishway will discharge into the existing creek approximately 50 feet downstream of the existing culvert outlet.

The second alternative proposed by WDFW consists of jacking a new 78-inch diameter steel culvert on the south side of the existing 42-inch diameter CMP at a slope similar to the existing culvert. Metal v-notch baffles measuring 3 feet high at the notch and 3.5 feet high on the sides will be welded every 28 feet down the length of the culvert to provide for a fishway within the proposed culvert. This design would eliminate the need for a fishway located at the downstream end of the culvert.

Discussion

There are a number of differences between the two alternatives. The first difference is cost. The difference at the conceptual level between the two alternatives is not believed to be significant. The second difference concerns operations and maintenance. Maintenance of the first alternative is typical of many culverts. The culvert is cleaned using a haul rope and tire dragged through the culvert to pull out and recover deposited materials. The fishway located at the outlet of the culvert will accumulate sediment but should be relatively straightforward to maintain using a vactor truck.

Maintenance of the second alternative is more complicated. A haul rope and tire can not be used in this situation because it would catch on the baffles. Discussions with WSDOT maintenance suggests that because of the confined space within the culvert, capital and resource constraints, that maintenance of the culvert would be limited to required maintenance at either end of the culvert and visual inspection into the culvert. Although it has been suggested that higher flows through the culvert may be self cleaning, it is anticipated that streambed material will be deposited behind the baffles up to the height of the notch in the baffles effectively creating a barrier if not continuously maintained.

The third difference is that WDFW views the concrete fishway located downstream of the culvert as old technology that is now believed to be an ineffective technology for passing fish. The new thought within WDFW is that a fishway within a pipe presents a more effective and efficient way of passing fish.

Conclusion

Assuming that the proposed alternatives are adequately maintained, both alternatives will provide fish passage. The significant difference between the two alternatives is the operations and maintenance of the facility. It is anticipated that the deposition of streambed material behind the baffles will create a continual maintenance problem that will require entry into a confined space that may ultimately result in creating a fish barrier. For this reason, the first alternative appears to be a more favorable design. Further design efforts should incorporate geotechnical and groundwater data and analysis as well as utility locates.

Interoffice Correspondence

August 19, 2004

DESIGN DECISION

By Brent Pember

Subject Locations of Noise Walls for I-405, SR520 to SR522 Project

Background

Initial noise wall locations were obtained from the Noise Report (Version 1, Draft) dated June 2004. Some of the locations made construction of the walls difficult and expensive. The design team decided to reevaluate the locations for ease of construction, cost reduction, and compatibility with the Implementation Plan. We determined that noise walls could be placed at a minimum distance of 3' from the ROW. This will allow room for a footing that extends 3' from the centerline of the wall to the ROW. A construction easement may be required.

Study

Cross Sections were taken at each noise wall location. First, the walls were checked to see if they were compatible with the Implementation Plan or if they were throw away walls. Then, using the top of wall elevation from the Noise Report, the height of each wall was determined. If the wall was taller than the 24' max shown on WSDOT Standard Plan D-2b, a new location was established. Walls taller than the standard height would require a special design and would be more costly. Finally, the design team met to determine our recommendations for each wall location.

Conclusion

Wall N1; place noise wall 3' from ROW on existing ground elevation. This location will be compatible with the Implementation Plan, but they will need to construct a cut wall at that time.

Wall N2; place noise wall 3' from ROW on existing ground elevation. This location will be compatible with the Implementation Plan. As shown, the very North end would be a conflict with the Implementation Plan, but Johnson Motors owns the two parcels at the North end of this wall. They had requested that no wall be placed here to improve their visibility. Ginette Lalonde (Parsons Brinckerhoff) will determine the new North end of the wall and report back to the design team.

Wall N3; place noise wall 3' from ROW on existing ground elevation. This location will be compatible with the Implementation Plan, but they will need to construct a cut wall at that time.

Wall N5; place wall 10' outside of Implementation shoulder. From the South end to gore of the ramp this wall will be placed between the Implementation mainline and ramp and not on the outside of the ramp. To build a wall outside of the proposed ramp would require a wall approximately 40' tall. Near the gore area of the ramp, the noise wall will cross the future ramp and be placed 10' outside of the ramp shoulder. When Implementation comes along, they will have to remove the part of the wall that crosses the future ramp. They will also have to do a noise study to determine if they need a wall along the ramp to mitigate the noise from the ramp.

Wall N7; place wall at the edge of the existing ramp from the South end to approximate STA 4372+00. This piece of the wall will be throw away in the Implementation Plan (about 1800SF). From STA 4372+00 to the North, place wall 3' from the ROW. This should make the required wall shorter and provide room for the Implementation Plan. The Southern part of the wall was not built at the Implementation Plan because it would have required a 2400 SF retaining wall that may or may not be compatible with the Implementation Plan.

Wall R1; place wall a variable distance from Implementation shoulder (10' min). To determine location, we started 3' inside the ROW and then went up at a 2:1 slope until we reached the Implementation shoulder elevation. This will cost about $70,000 extra in earthwork, but it will make the wall compatible with Implementation and provide room for drainage improvements during the Implementation phase and reduce the height of wall needed compared to placing it 3' from the ROW.

Wall R2; place wall 3' from ROW at Implementation shoulder elevation. The Southern 100' of this wall will not be compatible with Implementation. Will require a retaining wall (approx 5' max) to stay within the ROW, but the majority of the wall will be compatible with the Implementation Plan.

Wall R3; place wall 5' from Implementation shoulder. This will require approximately 25,000 CY of additional fill material. The pond and noise wall will both be compatible with Implementation Plan. Our previous pond design would not have been compatible.

Wall U4; place wall as shown in the Noise Report. This wall is about 5' from the ROW, but we do not want to move it closer to the ROW due to concerns about a utility line in this location. It will be compatible with the Implementation Plan; a cut wall may necessary.

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Forbes Creek Watershed Opportunities

July 9, 2004

Attempts to Integrate Stormwater Improvements and Watershed Opportunities

Washington State Department of Transportation

Table of Contents

Forbes Creek Watershed Opportunities

Introduction
The I-405 team has investigated opportunities to integrate stormwater improvements with broader watershed improvements in Forbes Creek. Specifically, the team examined the feasibility of creating an off-site surface water pond while simultaneously daylighting a section of Forbes Creek and removing barriers to fish passage downstream of I-405. This paper documents efforts to develop a design meeting both stormwater requirements and watershed improvement goals.

Purpose
This paper documents efforts by the WSDOT I-405 team to develop proposals for watershed based improvements to Forbes Creek, within the City of Kirkland, and recommends no further action.

Background
Scheduled improvements to I-405 as part of the Kirkland Nickel Project would require the provision of substantial surface water controls within the Forbes Creek drainage area. Initial drainage investigations indicated that it would be necessary to construct a stormwater vault to provide necessary detention, as the very limited WSDOT ROW available made construction of an open pond infeasible. High costs associated with vault construction and the mediocre environmental performance of vaults encouraged the project team to investigate potential watershed solutions, while still meeting stormwater management needs, within the Forbes Creek watershed.

Preliminary Investigation: I-405 water resource staff performed a reconnaissance of field conditions within the watershed, and met in the field on separate occasions with local experts to discuss the existing stream conditions, previous fish passage and stream enhancement efforts, and potential watershed projects that could improve stream conditions while simultaneously meeting WSDOT surface water needs. Experts included Jenny Gaus (City of Kirkland surface water engineer), Bill Way (local stream and wetland restoration expert with extensive local knowledge of Forbes Creek and past projects), Kurt Buchanan (WDFW liaison for WSDOT Urban Corridor Projects), and Pat Klavas (WDFW member of the MAPT team).

Stream Conditions: The upper watershed (upstream of I-405) supports a population of cutthroat trout. The upper watershed has good water quality, extensive remaining wetland systems, well vegetated stream buffers and relatively low density for urban development. A number of small blockages exist within the upper watershed, making portions of the stream system unavailable to migratory fish. Recent sewer improvements and upcoming Comprehensive Planning efforts within Kirkland may result in increased density in the upper watershed over the next 10 years, potentially impacting upper watershed stream health and peak flows.

Forbes Creek crosses I-405 in a 36” CMP culvert approximately 450 feet long, with a drop of several feet at its outlet. The current culvert is not fish passable due to length, slope, water velocities and the drop barrier at the downstream end of the culvert.

Downstream of I-405 the stream passes through a short ravine which has been deeply incised by high stream flows. While initial field visits concluded that there might be potential spawning habitat within the ravine, subsequent work concluded that the ravine was not suitable for spawning due to the deep incision and poor remaining substrate.

Below the ravine the stream passes under the Airshow Properties parking lot in a culvert approximately 350 feet long, which ends in a vertical drop onto a large pile of quarry spalls. This culvert effectively ends any upstream fish migration, and is a likely fatal obstacle for downstream migrants.

Several other fish passage barriers or partial barriers exist as one progresses downstream from the Airshow Property. A partial barrier (velocity) exists where the stream crosses the Burlington Northern railroad. An old dam near Forbes Creek Drive creates a complete blockage. A failing culvert at the

Metro access road creates a complete blockage. A concrete weir and sediment pond at the Forbes Creek Apartments also creates a complete blockage. Several of these blockages have previously been repaired to allow fish passage and have since reverted to a blockage due to erosion related to high stream flows.

A large, low gradient wetland system exists in the lower basin stretching from the mouth at Lake Washington approximately 3,000 feet upstream.

Design Development
The Project design team developed an initial concept for creating an off-site surface water pond, daylighting a section of Forbes Creek, and removing barriers to fish passage. Subsequent investigations resulted in a series of design refinements and iterations attempting to achieve initial design goals of creating improved watershed conditions while still providing needed I-405 stormwater management improvements.

Initial Proposal:

- Relocate and daylight stream around parking lot, removing fish passage barrier.
- Provide access to ravine gravel for salmon spawning habitat.
- Create wetland and/or R/D pond in abandoned stream channel for freeway flows.

→Geologic investigations indicated that this option was not feasible due to unstable nature of adjacent hillside.
→Estimated cost for this approach including ROW, construction and design costs was approximately $8M.

First Design Iteration: Design modified to reduce geologic risk

- Moved creek relocation away from hill to minimize geologic risk.
- Added stabilization wall in vicinity of southern hillside to minimize hillside issues.
- Added stabilization walls along daylighted stream channel due to depth below existing grade, need to protect remaining parking area.
- Pond outline modified to accommodate other design changes, capacity reduced.

→Depth of excavation to daylight creek caused concerns over biological viability, slope stability.
→Addition of walls added to cost.
→Estimated cost for this approach including ROW, construction and design costs was approximately $8.1M .

Second Design Iteration: Design modified in response to detailed survey

- Additional parking impacts from greater excavation depth.
- Additional wall needed for north side of stream.
- Additional concerns over hillside stability.
- Higher costs from greater excavation depth and new walls.
- Pond outline modified to accommodate other design changes, capacity reduced.

→Costs associated with the extensive stabilization walls (parking lot, stream both sides, hillside) caused concerns over cost/benefit of effort.
→Depth below grade of "daylighted" stream channel caused concern of biological viability and bank stability of new stream reach.
→Cost for this iteration was not estimated, but would be expected to be larger than previous iterations.

Third Design Iteration: Design modified to reduce costs, construction impacts and risk

- Stream routed through 150' culvert across west edge of parking lot, reduces excavation issues but raises fish passage design issues.
- Reduced wall costs by relocating stream channel to more stable area, shortening portion of creek daylighted.
- Increased impacts to parking lot may require additional ROW.
- Pond outline modified to accommodate other design changes, capacity reduced.

→Design team working to address fish passage issues when new information (Metro sewer line) identified.
→Estimated cost for this approach including ROW, construction and design costs was approximately $8.4M.

Fourth Design Iteration: Design modified to address conflicts with 72"sewer line

- Relocate approximately 700 feet of sewer line (potential construction feasibility issues).
- Relocate and daylight stream similar to iteration #3.
- Requires extensive use of walls, some up to 30' tall.
- Results in two long culverts (150', 200') at marginal slopes for fish passage (3.6%).
- Pond outline modified to accommodate other design changes, capacity reduced.

→ Routing stream over 72" sewer line infeasible due to elevation issues.
→ Routing stream under 72" sewer line infeasible due to elevation issues.
→Cost for this iteration was not estimated, but would be expected to be substantially larger than previous iterations.

Fifth Design Iteration: Design modified for trap-and-haul fish passage

- Create new culvert outlet to eliminate large drop onto rock pile which kills downstream juvenile migrants.
- Create fish trap facility to capture anadromous fish migrating upstream, prior to relocating them above the ravine and several fish barriers in the immediate vicinity.
- Pond outline modified to accommodate other design changes, capacity reduced.

→Cost for this iteration was not estimated.
→Inability to create sufficient pond storage volume needed for project limited benefits.
→Fisheries concerns over effectiveness of trap-and-haul as passage strategy.

Benefits

Benefits initially anticipated from locating detention outside ROW were not fully realized:

- Benefits from creation of stormwater pond were smaller than anticipated. Site constraints limited stormwater pond size to 1.5 – 2.0 acre/feet of storage volume in all iterations, while 7+ acre/feet of storage is needed. Remaining storage needs would require construction of an additional stormwater facility which, due to the limited siting opportunities in the area, would need to be a constructed vault within the existing ROW. Construction of a vault significantly reduces anticipated benefits and cost savings from eliminating a separate drainage facility within ROW.

- Benefits from providing fish passage to ravine were smaller than anticipated. Habitat degradation in ravine due to high storm flows has virtually eliminated spawning potential in this reach.

- Benefits from daylighting stream were difficult to realize. Geologic risk, depth of excavation needed to daylight stream, conflicts with 72" sewer line limited benefits while raising costs and engineering challenge substantially.

Potential Drawbacks

A number of potential drawbacks were identified during project investigations:

- Inability to create pond sufficiently large to eliminate vaults within ROW limits cost-effectiveness of proposal.

- Geologic risk from raveling hill to south, and inherent risk of lawsuits for property damage from owners along top of hill, create substantial risk.

- Extent of walls needed to stabilize hill, stream channel, parking lot and sewer line make this a much larger disturbance and greater risk than initial proposal.

- Challenges associated with obtaining permission and physically relocating 72" gravity sewer line adds to costs and schedule uncertainty.

Assumptions
All iterations assumed that ROW could be obtained from the City of Kirkland and from affected property owners through willing-seller arrangements. Should condemnation be required, both schedule and cost would increase substantially, as would risk.

Essential Components
To be affective at addressing initial project design goals requires sufficient storage volume to significantly reduce stormwater facilities within the I-405 ROW. This goal was not met. Without significant surface water storage benefits, there is little justification for linking the out-of-ROW facility to roadway needs and purposes.

Funding Needs
The first three iterations are estimated to cost between $8 M – $8.5M. Subsequent iterations were not estimated due to larger structural costs and limited effectiveness.

Recommendations
The feasibility of creating an off-site surface water pond while simultaneously daylighting a section of Forbes Creek and removing barriers to fish passage downstream of I-405 was investigated as a potential watershed improvement effort.

Based on the discussion above, we recommend that the watershed improvement concept for Forbes Creek be abandoned. The principle factors leading to this recommendation include:

- Limited stormwater storage capacity due to steep slopes and other physical site constraints.
- High level of geologic hazard posed by steep slope to south, creating risk to residential structures.
- Presence of Metro 72" sewer line at critical elevation, limiting stream relocation options.
- Depth of excavation needed to daylight stream greater than anticipated.
- Extensive construction of costly retaining walls required to allow stream and parking relocation.
- Limited habitat quality in area that would be opened to fish access.
- Larger ROW needs than anticipated due to extent of excavation and wall construction.
- Inability to identify cost-effective alternative to constructed stormwater vault in existing ROW.

Conclusions
Although the watershed approach to addressing surface water requirements did not prove to be effective at this location due to the site limitations described above, substantial improvements to the existing condition of Forbes Creek will result from the construction of the Kirkland Nickel I-405 Improvements.

- After construction, all runoff from the new project pavement routed to Forbes Creek will receive enhanced water quality treatment through the use of ecology embankment integrated into the collection and conveyance system, whereas runoff currently receives no water quality treatment.
- Freeway runoff from the new project pavement will also be detained prior to being discharged to Forbes Creek, reducing downstream erosion and other flow related problems. No detention is currently provided.
- The I-405 team continues to work closely with representatives from WDFW to develop an effective fish passage design for improving the Forbes Creek culvert crossing under I-405. Funding for fish passage improvement is contained within the project budget.

Interoffice Correspondence

July 9, 2004

DESIGN DECISION

By Brent Pember

Subject Superelevation Rates & Transitions

Background

Initially, the scope of the I-405, SR520 to SR522 Project (also referred to as the Nickel Project) intended the widening of the existing pavement (where an additional lane was to be added) by matching the existing cross slope. Superelevation rate, transitions and run-out length were intended to remain as they exist.

I-405 was initially constructed as 3 lanes in each direction. The HOV lane project added one lane to the pavement section by widening to match the existing roadway cross slope.

Superelevation run-out design is a function of roadway width and is measured from the crown line to the outer edge of pavement — the wider the pavement, the longer the transition. Thus, the HOV project resulted in the construction of non-standard superelevation run-out lengths. In addition, the required superelevation rates have changed since the original construction of the roadway.

Pavement analysis concluded that an overlay is to be included in the Kirkland Nickel. This is an opportune time to correct the crown location, superelevation rates, and transition lengths.

Study

The superelevation rate required for each curve was computed using the WSDOT Design Manual, Section 640. Compound curves were treated as a single curve with the smaller radii being used to calculate the required superelevation rate.

Cross sections were then cut to determine existing superelevation rates. The existing superelevation rates were compared to the computed superelevation rates. Differences between existing and computed superelevation rates were discussed and resolved to determine the proposed superelevation rates for the Nickel Project.

The transitions lengths were computed for our proposed superelevation rates. Instances (in reverse curve areas) where the computed normal crown stations overlapped were discussed with John Milton of WSDOT and conflicts were resolved. The new full depth replacement pavement at NE 116th St. will be widened in the future for the Implementation Plan.

Conclusion

If the existing and computed superelevation rates are different, we will use the one with the higher rate of superelevation. This will reduce the amount of grinding needed. If the superelevation is over an existing bridge, we will use the existing rate on the bridge to avoid having to replace the bridge deck. See summary tables below for superelevation rates (Table 1.0 and Table 2.0):

Table1.0 NB405 Superelevation Rates

NB405						
Curve	**STA**	**STA**	**Existing Super**	**Computed Super**	**Proposed Super**	**Comments**
1	4086+50	4106+12	3.75%	3%	3.75%	Match Existing
2	4110+45	4120+67	6%	6%	6%	Per WSDOT Manual
3	4123+88	4137+82	3.75%	3%	3.75%	Existing Structure at NE85th
4	4155+11	4181+86	2%	NC	2%	Match Existing
5	4204+86	4227+28	5%	4%	5%	Existing Structure at BNSF, North of NE116th

Table2.0 SB405 Superelevation Rates

SB405						
Curve	**STA**	**STA**	**Existing Super**	**Computed Super**	**Proposed Super**	**Comments**
1	4091+94	4101+87	5%	6%	6%	Per WSDOT Manual
2	4110+84	4121+10	5%	6%	6%	Per WSDOT Manual
3	4123+97	4138+03	3.75%	3%	3.75%	Existing Structure at NE85th
4	4155+33	4181+99	2%	NC	2%	Match Existing
5	4205+37	4228+76	5%	4%	5%	Existing Structure at BNSF, North of NE116th
6	4284+41	4304+55	5%	5%	5%	Per WSDOT Manual
7	4317+29	4321+11	2.5%	4%	4%	Per WSDOT Manual
8	4348+96	4360+38	2%	2%	2%	Per WSDOT Manual
9	4386+20	4405+55	3%	3%	3%	Per WSDOT Manual

The superelevation transition for NB405 between Curve 1 and Curve 2 will use a reverse curve transition from full super to level to full super without a normal crown section because the curves are too close to provide a transition to normal crown section.

The superelevation transition for NB405 between Curve 2 and Curve 3 will use a reverse curve transition from full super to level to full super without a normal crown section. In addition, the point of rotation will be moved to the center of the traveled way instead of the horizontal control line of NB405. This results in a smaller rotated travel way width, and in turn, a shorter transition. These steps are necessary to allow the superelevations to transition at the standard rate. This applies only to the transition between Curve 2 and Curve 3. Since there is no normal crown section, the shift of pivot point will be practically unnoticeable by the driver. Curve 3 will transition out using a standard superelevation transition.

The remaining NB405 superelevation transitions will use WSDOT standard superelevation transitions.

The superelevation transition for SB405 between Curve 2 and Curve 3 will use a reverse curve transition from full super to level to full super without a normal crown section. In addition, the percent of the superelevation runoff on the tangent will be shifted from 70% to 60% and the point of rotation will be moved to the center of the traveled way instead of the horizontal control line of SB405. This results in a smaller rotated travel way width, and in turn, a shorter transition. These steps are necessary to allow the superelevations to transition at the standard rate. This applies only to the transition between Curve 2 and Curve 3. Since there is no normal crown section, the shift of pivot point will be practically unnoticeable by the driver. Curve 3 will transition out using a standard superelevation transition.

The remaining SB405 superelevation transitions will use WSDOT standard superelevation transitions.

The transition lengths for both NB405 and SB405 Curve 5 were computed using the Implementation pavement widths instead of the Nickel Project widths. This pavement is a full depth replacement, will be permanent, and planning for the Implementation widening is justified.

Interoffice Correspondence

June 8, 2004

DESIGN DECISION

By Garth Merrill

Subject Traffic Signals at NE 116th Street SPUI Interchange

Background

The NE 116th Street under crossing interchange with I-405 will be reconfigured into a ½ - Single Point Urban Interchange (SPUI), with a traffic signal.

Due to the alignment of the I-405 bridges and the superelevation required, the minimum vertical clearance of 16'-6" at the low point of the bridges over NE 116th Street is being provided in the preliminary design. The purpose of this memo is to evaluate the preliminary traffic signal layout for the intersection of the I-405 ramps at NE 116th Street. In a typical Single Point Urban Interchange (SPUI) design in Washington, signal heads are attached under the bridge structure in a horizontal arrangement. Due to the minimum vertical clearance issues raised, further evaluation of the signal head location was considered to ensure MUTCD requirements can be satisfied.

Analysis

Eastbound NE 116th Street Approach

The west edge of the SB I-405 bridge structure has the lowest vertical clearance along NE 116th Street. One option considered for SPUI signal head placement is on the bridge fascia. This would require the stop bar to be placed a minimum of 40' west of the bridge. However, there is a limited distance of approximately 240' between 120th Ave NE and the bridge structure. Consideration must be given to maximize the limited available queue storage. It is recommended the stop line be located as close to the intersection as possible to maximize the queue length.

Due to superelevation of mainline I-405, the alignment of the bridges will be sloped with the west edge being the lowest point with the least vertical clearance and the east side of each bridge higher, providing more vertical clearance. Reviewing a cross-section of I-405 along the NE 116th Street centerline, it was determined there is adequate vertical clearance to locate the signal heads horizontally under the bridge structure. NE 116th Street has a sag vertical curve as it goes under the structure which will limit the visibility of these signal heads. This can be addressed by placing a near-side post-mounted signal head at the stop bar for the eastbound approach.

Westbound NE 116th Street Approach

The east edge of the NB I-405 bridge has the highest clearance. As with the eastbound approach, consideration needs to be given to maximize the storage queue lengths, especially for the westbound NE 116th Street to southbound I-405 on-ramp. Two options may be considered, mounting the heads on the bridge fascia and placing the stop bar a minimum (approximately 50' depending on actual mounting height) distance in advance of the signal bridge or hanging the signal heads horizontally, approximately in the center of the bridge and providing minimum vertical clearance. In either case, a near-side supplemental head is recommended. A pedestal post should also be provided on the south side between the two bridges to provide a secondary indication for the left-turn movement (a supplemental through indication could also be provided for the eastbound direction).

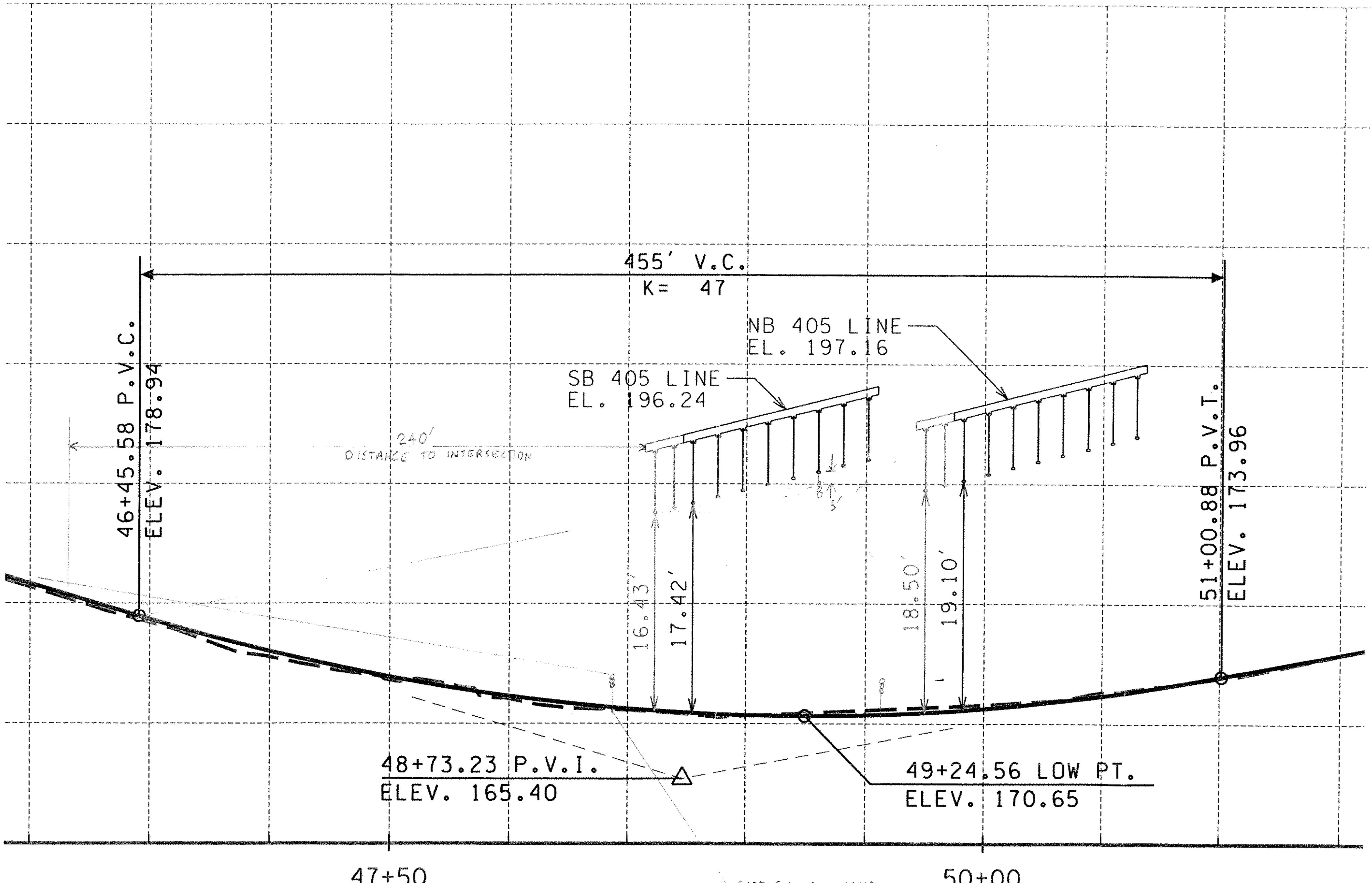
NORTHBOUND I-405 OFF-RAMP APPROACH

For the left-turn movement, it is recommended two signal heads be post-mounted on the north side of NE 116th Street between the two bridges. Visibility of the signal heads if mounted under the structure would be difficult based on the approach angle and may lead to confusion for westbound traffic. A supplement through signal head may also be mounted to one of the posts for westbound through traffic. Space may be limited to fit posts due to the bridge abutment on the north side, if this proves to be a limiting factor, the signals may need to be mounted to the abutment wall.

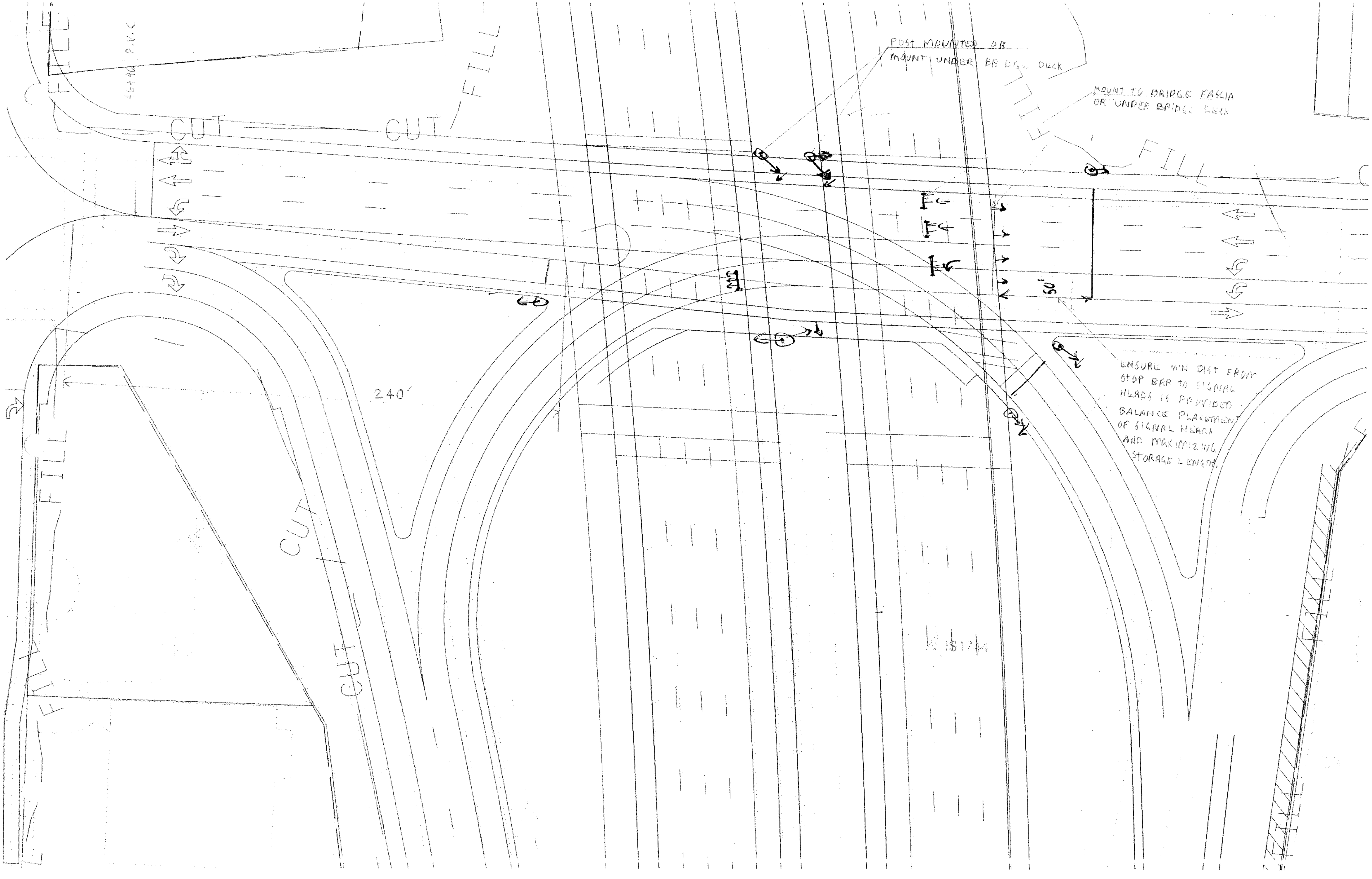
Two near-side signals should also be placed at the stop bar, especially with the potentially higher speed of vehicles approaching from the freeway.

Conclusion

Preliminary sketches were prepared to determine likely locations for signal head placement. Reviewing each approach and the current proposed geometry of the bridge structures it was determined there are adequate locations for installation of the traffic signal that will satisfy MUTCD requirements. The sketches will be kept with relevant project data but are not anticipated to be provided as part of the RFP documents to optimize potential design innovation. Standard traffic signal design criteria including requirements within the MUTCD will govern the design-builder's design.



SIGHT DISTANCE TO SIGNAL MOUNTED UNDER
BRIDGE IS APPROX 220'


POST MOUNTED OR
MOUNT UNDER BRDG. DECK
MOUNT TO BRIDGE FASCIA
OR UNDER BRIDGE DECK
ENSURE MIN DIST FROM
STOP BAR TO SIGNAL
HEADS IS PROVIDED
BALANCE PLACEMENT
OF SIGNAL HEADS
AND MAXIMIZING
STORAGE LENGTH.
50'
240'
CUT
FILL

Interoffice Correspondence

June 4, 2004

DESIGN DECISION

By Gene Niemasz

Subject Crown Relocation for I-405, SR520 to SR522 Project

Background

Some sections of the I-405, SR520 to SR522 Project (also referred to as the Nickel Project) will be brought up to full standard 10′ inside and 10′ outside shoulders (Typical Section 1, page 3). On other sections of the project, the existing inside shoulder will be re-striped as traveled way (Typical Section 2, page 3). As a result, the existing crown line would not be on a lane line in almost all cases when the project is complete.

Study

The feasibility of adjusting the crown to a lane line for the project has been analyzed. Any adjustment to the crown location would involve pavement grinding and overlay. Crown relocation or pavement overlay were not included in the initial project scope.

As part of the crown analysis, the project was compared to the Implementation Plan (IP) (Typical Section 3, page 3) to determine if the crown could be relocated to optimally satisfy both designs. In most cases the IP will reconstruct much of the added pavement in the 70th/85th I/C area and the 160th I/C area. The section north of 132nd is superelevated, so no crown issue exists there.

Between 85th and 116th, the finished pavement surface in this project could be used for the IP project. The Nickel Project will construct a full standard section in this area, 7,000′ NB and 7,600′ SB. Generally, the crown relocation would require pavement grinding and variable thickness overlay within the mainline travel lanes – again beyond any scope efforts that have previously been studied.

A portion of the full standard section (Sta 4198+94 and 4218+93 (2,000′) NB, and Sta 4203+63 and 4219+63 (1,600′) SB) will require full reconstruction of the mainline (in this project) to replace the 116th mainline structures, so the crown will be reestablished in this area.

If the crown is not shifted for the rest of the section, transition sections will be required to shift the crown from the existing location to the proposed location in the vicinity of 116th, as described above. On the south end, this shift would occur in a tangent (crown) section, on the north it would occur in a curve (superelevated) section. In a tangent section, this transition may be felt while driving, in the curve section, the transition is only virtual, because of the superelevated section (it is a crown line in name only).

The current corridor-wide configuration sets the IP crown between the #4 and #5 GP lanes—setting the crown at 38′ (10′ Shld. + 12′ HOV + 4′ Buffer + 12′ GP) from the inside edge of shoulder. The Nickel Project would set the crown at 34′ (no 4′ Buffer) from the inside edge of shoulder. Thus, the 4′ buffer complicates the strategy of building the Nickel Project to best suit the IP.

A possible solution to the buffer/crown location issue, is to locate the crown between the HOV lane and the #5 GP lane—22′ from the inside shoulder (10′ Shld. + 12′ HOV). In moving from the Nickel to the IP, the crown would remain on the HOV/GP lane line, and the buffer would be striped to the outside of the crown line. This shift would result in negative roadway drainage characteristics, however. In a crown section, drainage would sheet flow an additional lane width (48′ in the Nickel and 60′ in the IP) to get off of the traveled way.

Another consideration is the NE 128th Street Direct Access project. The PS&E plans show reconstruction of significant portions of the mainline for approximately 3,600′ (between 124th and 132nd). This will reset the crown line at 10.2 meters (34′) from the edge of inside shoulder.

Additional considerations are pavement selection and life cycle for the existing pavement. The paved surface between SR520 and SR522, with the exception of bridge decks, is asphalt concrete pavement (ACP). Data provided by the WSDOT materials group indicate that the pavement life cycle averages 12 years in this area before resurfacing is required. Pavement resurfacing typically consists of overlay of all travel lanes, and grinding where necessary. The optimal timing for relocation of the crown would be at the end of the pavement life cycle. The pavement was resurfaced in 1997-98 in the Kirkland segment. A detailed pavement analysis is attached as Table 1.

The current construction schedule plans for construction beginning in July 2006 for Stage 1 (85th – 124th), and July 2009 for Stage 2 (remainder of the Nickel Project). The age of the pavement surface would be 8 years and 11 years respectively for Stages 1 & 2, under that schedule.

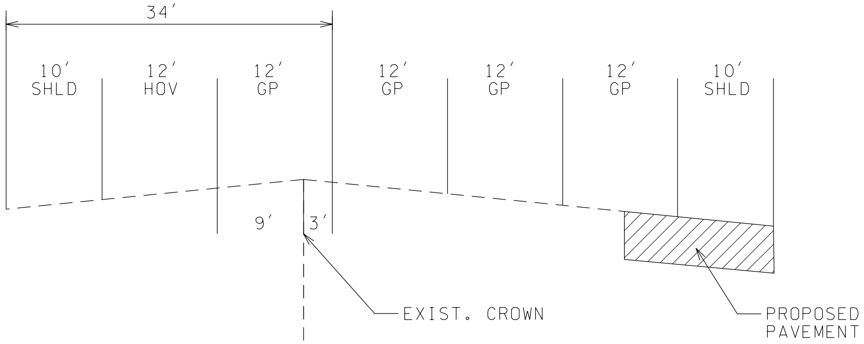
The footprint for the crown shift work between 85th and 116th would cover 3 travel lanes (HOV and GP#2 and #3) and add approximately $2 million to the cost of the project [(55,556 SY) x ($20/SY pvmt. + $5/SY cold planning) + ($500,000 MOT and striping) + ($100,000 adjust inlets to grade)]. The maintenance of traffic efforts for the crown shift are nearly identical to what would be needed for an overlay operation. The costs for shifting the crown have never been carried in the scope for the Nickel Project.

Nickel project deviations were also considered in the crown analysis. A deviation roll plot was developed to illustrate type and location of all known design deviations. The deviation plot was aligned with a channelization and existing crown plot to study cumulative effects from a safety perspective.

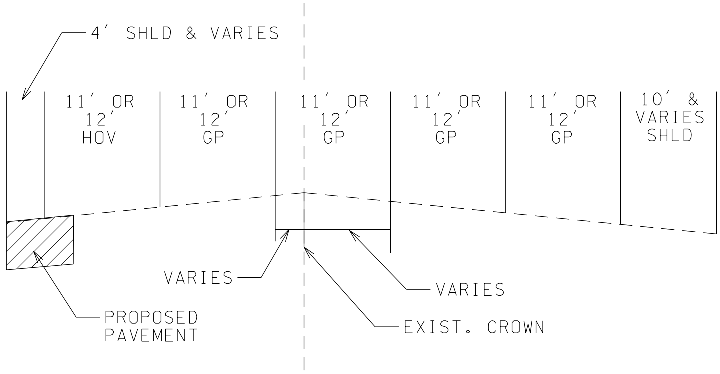
At the writing of this paper, the IP has been scaled back to "Option D", which would only construct elements north of NE 124th Street. Further, a public vote to secure funding for the IP has been delayed, so the scope and schedule for the IP is undetermined.

Several meetings were held with WSDOT I-405 project managers to convey information and assist with the crown relocation decision.

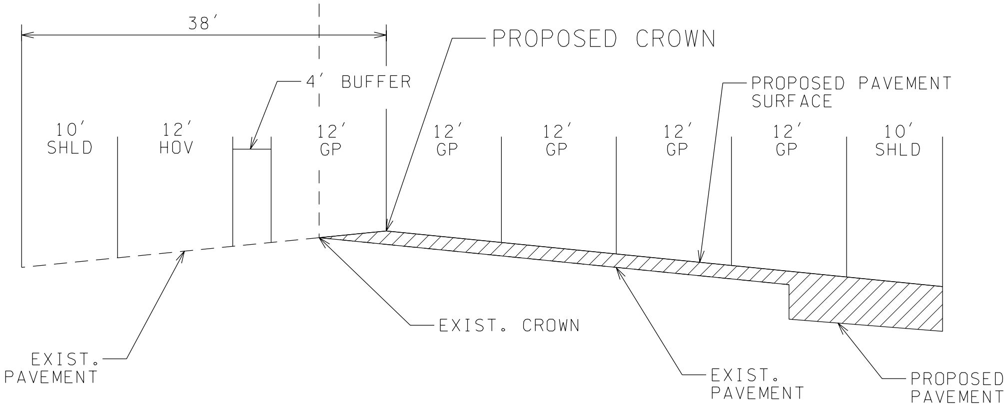
KIRKLAND TYPICAL SECTIONS FOR CROWN ANALYSIS



KIRKLAND NICKEL
TYPICAL SECTION 1 - FULL STANDARD

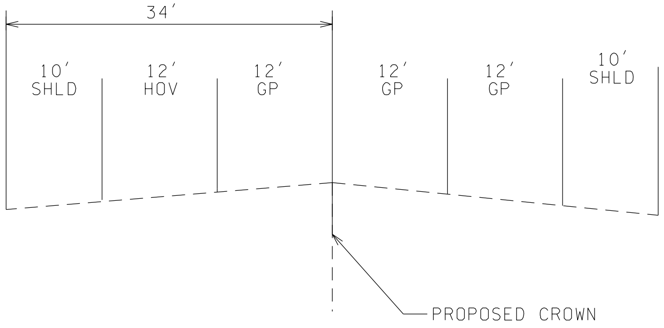


KIRKLAND NICKEL
TYPICAL SECTION 2 - DEVIATED SECTION

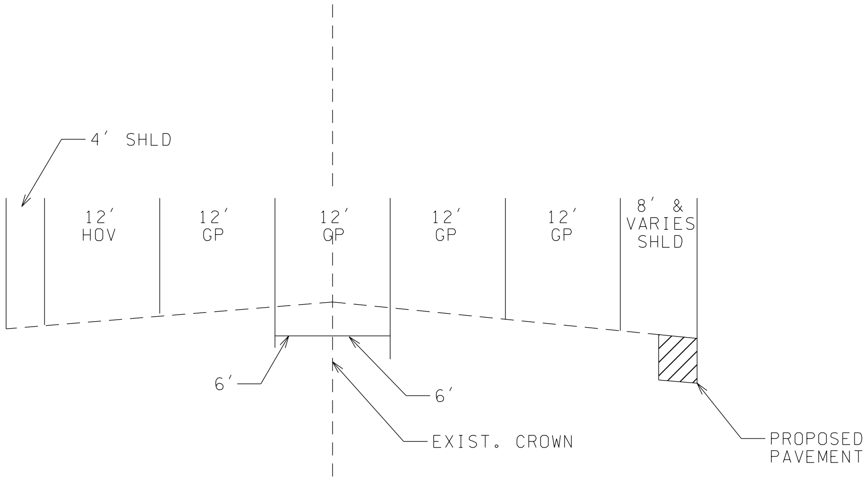


IMPLEMENTATION PLAN
TYPICAL SECTION 3 - FULL STANDARD

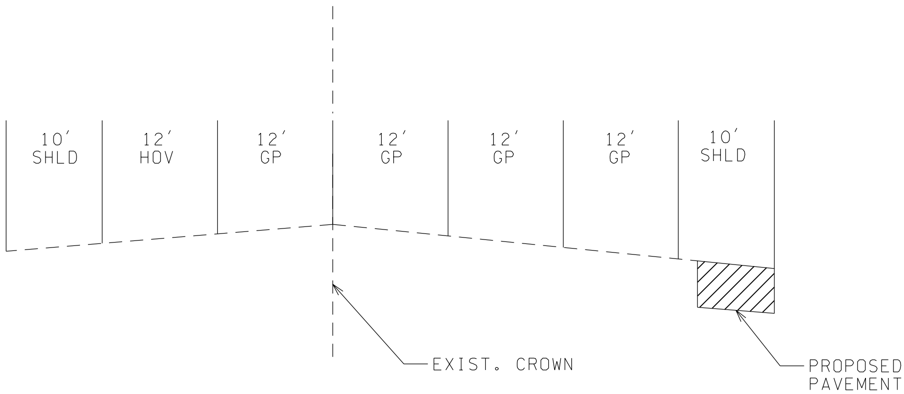
KIRKLAND TYPICAL SECTIONS FOR CROWN ANALYSIS



KIRKLAND 128TH PROJECT
TYPICAL SECTION 4 - PROPOSED 128TH



KIRKLAND NICKEL
TYPICAL SECTION 5 - DEVIATED SECTION, 128TH PROJECT LOCATION



IMPLEMENTATION PLAN
TYPICAL SECTION 6 - FULL STANDARD, NO 4′ BUFFER

Conclusion

Considering safety, cumulative deviations, pavement life cycle and the nebulous nature of the Implementation Plan scope and schedule, it was decided to incorporate a crown shift and overlay into the Nickel Project scope.

The crown location will be set between the #3 GP and #4 GP lanes (34' from the left EP in the full standard section) and will remain on this lane line through the deviated sections. Overlay shall be 2" minimum, with grinding as needed to accommodate the crown shift.

The conceptual plans will be revised to reflect the crown relocation and overlay. Revised elements will include: shifting of the baseline, adding profile and superelevation plans to the entire project limits and revising typical sections.

The 128th Direct Access project crown location is consistent with this strategy in the full section area. Some rework may be required to set the crown at the Nickel Project location in the deviated section. To minimize rework, the strategy is to have one WSDOT Construction Project Engineer oversee both projects, as they should be under construction concurrently.

Interoffice Correspondence

June 2, 2004

DESIGN DECISION

By Brent Pember/Gene Niemasz

Subject Sight Distance at NE 116th Street SPUI Interchange

Background

The NE 116th Street under crossing interchange will be reconfigured into a ½ - Single Point Urban Interchange (SPUI), with a traffic signal. The new bridge will have vertical wrap-around abutment walls from the bridge soffit down to NE 116th Street. This study will assess left-turn stopping sight distance for the NB off-ramp and SB on-ramp in context with the abutment walls, which are a visual obstruction for left turning vehicles traveling through the interchange.

Alternatives have been studied to optimize the design of the interchange under a separate Design Decision paper – see Design Decision "NB & SB 116th Street Structures & Crest Vertical Curves", dated May 27, 2004.

The WSDOT Design Manual (DM) has no specific SPUI design standards. For study purposes, DM Section 910.10 *Sight Distance at Intersections* and Figures 650-9 *Horizontal Stopping Sight Distance* and 910-18b *Sight Distance at Intersections* were used. Figure 910-6 *Sight Distance for Turning Vehicles* applies only to stop controlled intersections, but was used for comparison values.

Study

For the purpose of this study, two methods for sight distance analysis were performed using the WSDOT DM; Sight Triangle and horizontal Stopping Sight Distance (SSD). The sight triangle was used for the stopped condition at the stop bar, and the horizontal SSD for the "green" signal condition as a vehicle negotiates the left-turn movement.

Sight Triangle

A stop condition was analyzed, assuming that a vehicle was stopped at a red light. DM Figure 910-18b *Sight Distance at Intersections* was used to determine the requirements for the sight triangle. By measurement, the SB on-ramp has a clear sight distance of 290'. The formula provided on Figure 910-18b yields an infinite number when the offset to a fixed object is equal to 18', and a negative number when the offset (23' in this case) is greater than 18'. The NB off-ramp line of sight is limited only by the NE 116th St profile and thus unobstructed by fixed objects for a vehicle sitting at the stop bar.

Horizontal Stopping Sight Distance

DM Figure 650-9 *Horizontal Stopping Sight Distance* was used to calculate the SSD, which was then compared to DM Table 650-2 to attain a design speed. The SB on-ramp and NB off-ramp have calculated SSD design speeds of 31 mph (206') and 33 mph (238') respectively. The radius for the curve meets a 25 mph design speed (SSD = 155'), so the calculated SSD exceeds the minimum required.

The Transportation Research Board report *National Cooperative Highway Research Program Report 345* titled, "Single Point Urban Interchange Design and Operations Analysis" provides guidelines for

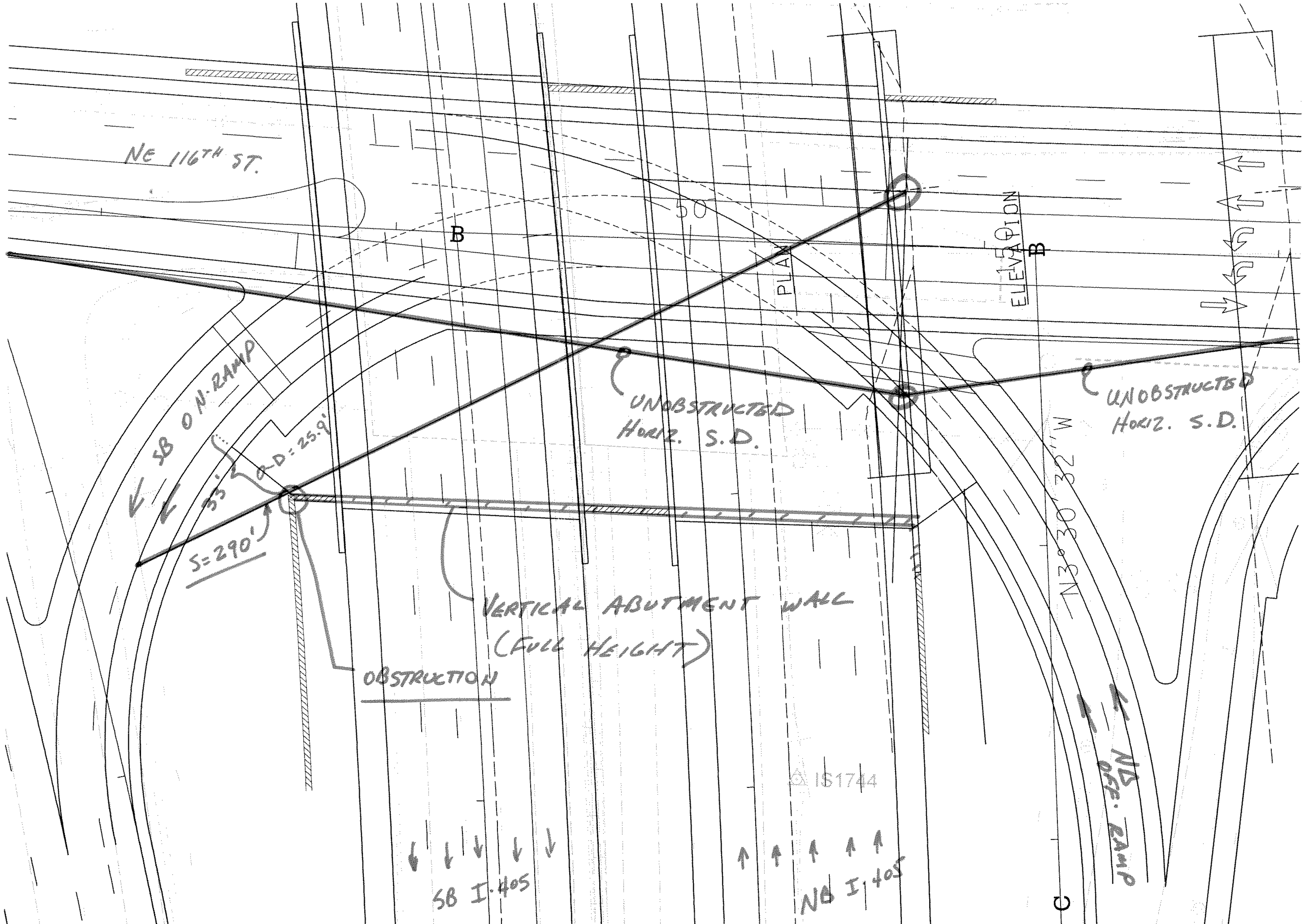
SPUI design. The AASHTO Green Book does not expressly address some SPUI operational elements and thus, Report 345 guidelines were intended to supplement the AASHTO Green Book for SPUI design. Table 5 on page 56 provides minimum lateral clearance to sight obstructions for left-turning vehicles. For a design speed of 25mph (167' minimum curve radius), the minimum lateral required clearance is 16.5' from the centerline of the inside turning lane – requiring a sight distance of 150'. The SB on-ramp has a minimum lateral clearance of 23', with a sight distance of 290'.

The left-turn movements of the SPUI at NE 116th Street exceed WSDOT sight triangle, and horizontal SSD requirements for a 25mph design speed. The offset distance to obstruction also exceeds the requirements set forth in the Transportation Board report 345 for a 25 mph design SPUI curve.

Since this project will likely be delivered via Design/Build, the reference documents, RFP materials and Design Criteria will establish minimum design requirements for left-turn movements in SPUI design. One approach is to define a minimum design speed for geometric elements, then follow the WSDOT Design Manual for curves and signalized intersection design. An alternative is to get specific with requirements for design speed, radii, offset to obstruction, sight triangle requirements, and horizontal SSD.

Conclusion

To optimize potential design innovation, the approach to SPUI design criteria will be to specify the left-turn design speed as 25 mph, and direct to the WSDOT Design Manual for standards. Conveyance of this information will be in the Project Specific Book of the RFP in a Table format, with the other design criteria.


NE 116TH ST.
B
50
PLAN
ELEVATION
B
SB ON-RAMP
UNOBSTRUCTED HORIZ. S.D.
UNOBSTRUCTED HORIZ. S.D.
33'
O.D.=25.9'
S=290'
VERTICAL ABUTMENT WALL (FULL HEIGHT)
OBSTRUCTION
N3°30'32"W
IS1744
SB I-405
NB I-405
NB OFF-RAMP
C

Interoffice Correspondence

March 8, 2004

DESIGN DECISION

By Gene Niemasz

Subject Removal and Replacement of Shoulders for I-405, SR520 to SR522 Project

Background

The I-405, SR520 to SR522 Project (also referred to as the Nickel Project) will require some new pavement and re-striping to add an additional travel lane northbound and southbound. When completed, much of the existing inside and outside shoulder areas will become portions of travel lanes.

Preliminary estimates for the Nickel Project assumed that the existing inside and outside shoulders of I-405 were constructed with the mainline travel lane's structural section, and thus able to handle traffic loads without performing remedial work.

The Coal Creek to Bothell HOV Project Contract Plans indicate that shoulder improvements were made as part of that work, but the proposed shoulders on the typical sections show 2" of asphalt concrete (AC) over aggregate base (AB)—well below traffic bearing capability. The structural section for traffic bearing lanes is shown as 0.95' AC over 0.20' AB. Additionally, the existing shoulder cross-slope grades are shown at 5%, compared with a 2% cross-slope for the travel lanes (tangent section). The current WSDOT design standard is to construct full-section inside and outside shoulders.

Study

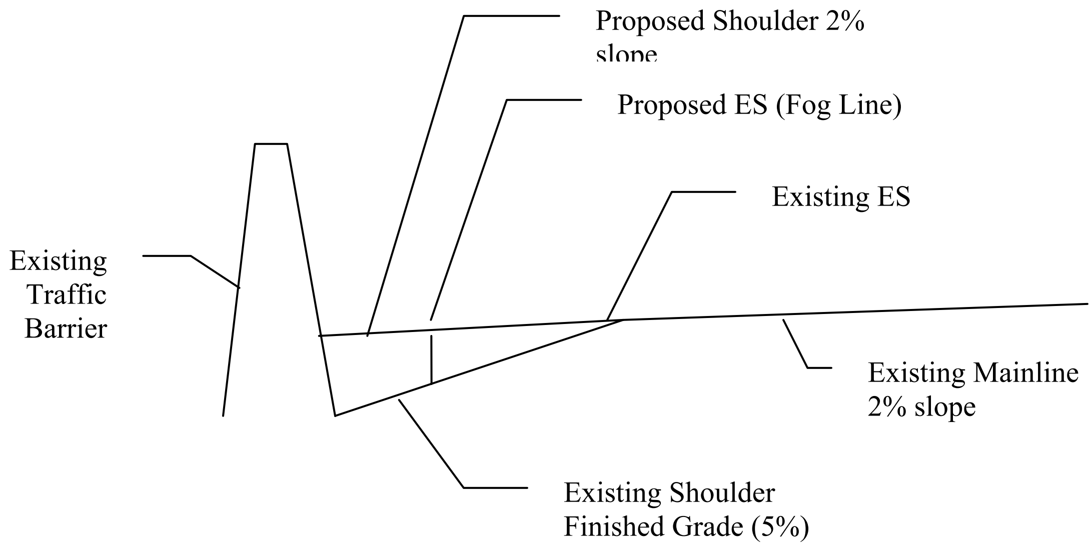
Shoulder Structural Section

At the direction of Kim Henry, AC coring samples were taken of the existing inside and outside shoulders at several NB and SB locations. The WSDOT Materials Testing Division data report dated, February 11, 2004, indicates that the AC in the shoulder section varies from 0.27' to 1.02'. The core sample data sheet and analysis is attached. The mean thickness is 0.51', with a standard deviation of 0.184. There is a 95% confidence interval that the mean thickness is between 0.436 and 0.584.

More than 95% of the samples are below 0.95' AC thickness. More than 88% of the samples are less than 0.60' thick.

Shoulder Cross-slope

Considering the shoulder cross-slope, if the portion of the existing shoulder that will become part of the traveled way is reconstructed at a 2% cross-slope, the entire shoulder should be reconstructed to avoid a vertical lip at the fog line.



There are many drainage inlets and signing/lighting pull boxes and a few other utility boxes in the existing **inside** shoulder that will require adjustment to grade if the shoulder cross-slope is adjusted to match that of the mainline traveled way. Generally, the drainage inlets are located up against the existing median traffic barrier, and would remain in the proposed shoulder. However, some of the pull boxes and other utility boxes may require relocation closer to the traffic barrier to keep them out of the HOV travel lane, when the shoulder is narrowed.

Conclusion

Only one of the core samples meets the structural section parameters for a travel lane – more than 88% of the samples are considered structurally inadequate. Wherever the existing shoulders will become part of a travel lane, the shoulder must be removed and replaced to accommodate traffic loads.

To meet the current WSDOT Design Manual standards, the entire inside and outside shoulders should be replaced with full structural section pavement. On tangent and low side of super-elevated sections, the shoulder cross-slope will be set to match the existing travel lane cross-slope. Drainage inlets, pull boxes and utility vaults must be set outside of travel lanes and at least one foot beyond the fog line, wherever possible. Cross-slopes for shoulders on the high side of super-elevated sections should be set according to the WSDOT Design Manual.